Chemical Reactions

Chapter 11

Chemical Equations

- **Word equations**
  - Write the names of the reactants to the left of the arrow (separated by a + sign) and write the products in a similar manner to the right of the arrow.

- **Chemical Equations**
  - Write the formulas of the reactants to the lefts of the yields sign (arrow) and the formulas of the products to the right.

Writing Equations

- Write either the word equation or chemical equation of the following:
  - Solid magnesium reacts with oxygen gas to produce magnesium oxide.
  - $Fe\ (s) + O_2\ (g) \longrightarrow Fe_2O_3\ (s)$
  - When heated, solid mercury(II) sulfide reacts with oxygen gas to produce liquid mercury and sulfur dioxide gas.
  - $CaCO_3\ (s) \xrightarrow{heat} CaO(s) + CO_2\ (g)$

Balancing Equations

- Use coefficients to balance an equation so it obeys the law of conservation of mass!
- Examples
  1. hydrogen + oxygen $\longrightarrow$ water
  2. zinc + hydrochloric acid $\longrightarrow$ zinc chloride + hydrogen
  3. nitric acid + magnesium hydroxide $\longrightarrow$ magnesium nitrate + water

Double Replacement Reactions

- A reaction in which **ions** in 2 compounds "exchange partners" to form 2 new compounds

- General Formula

$$AB + XY \longrightarrow AY + XB$$

- This reaction will occur if…
  - An insoluble product (precipitate) forms
  - Gas is given off
  - Liquid water is formed

Double Replacement Examples

- lead (II) nitrate + potassium iodide ⟶
- iron (II) chloride + potassium sulfide ⟶
- calcium hydroxide + hydrochloric acid ⟶

Double Replacement Examples

- sodium acetate + potassium bromide ⟶
- potassium phosphate + magnesium chloride ⟶
- sodium hydroxide + phosphoric acid ⟶
- potassium sulfate + calcium nitrate ⟶

Net Ionic Equations

- Shows only those particles involved in the reaction.
- Spectator ions or those ions not directly involved in the reaction are left out of these equations.

Only aqueous (aq) splits!!

Solids (s), liquids (l) & gases (g) don't split!

Net Ionic Equations

- $BaCl_2\ (aq) + Na_2SO_4\ (aq) \longrightarrow BaSO_4\ (s) + 2NaCl\ (aq)$

Net Ionic Equations

- $HCl\ (aq) + ZnS\ (aq) \longrightarrow H_2S\ (g) + ZnCl_2\ (aq)$

Net Ionic Equations

First complete the reaction (& balance), then write the net ionic equation…

- Silver nitrate + sodium chloride $\longrightarrow$

Single Replacement Reactions

- A reaction in which 1 element takes the place of another element as part of a compound.
  - **Metals always replace another metal**
  - **Nonmetals always replace another nonmetal (only halogens)**
    - Fluorine is the most reactive, iodine the least reactive!

Single Replacement Examples

- If solid zinc metal is placed in an aqueous solution of copper (III) sulfate will a reaction occur?

- $Al + H_2SO_4 \longrightarrow$

Single Replacement Examples

- If solid silver metal is placed in an aqueous solution of potassium nitrate will a reaction occur?

- $Cl_2 + KI \longrightarrow$

Decomposition Reactions

- A reaction that occurs when **1 reactant** breaks down into **2 or more products**.

$Ag_2O \rightarrow Ag + O_2$

$PCl_5 \rightarrow PCl_3 + Cl_2$

$H_2O_2 \rightarrow H_2O + O_2$

$CuO \rightarrow Cu + O_2$

Specific Decomposition Reactions

- $MCO_3 \rightarrow MO + CO_2$

  Where M is any metal!

  $CaCO_3 \rightarrow$

- $MOH \rightarrow MO + H_2O$

  $LiOH \rightarrow$

- $MClO_3 \rightarrow MCl + O_2$

  $NaClO_3 \rightarrow$

Specific Decomposition Reactions

- Acid → H_2O + remainder of elements

  H_2CO_3 →

  H_2SO_4 →

  H_2SO_3 →

- $NH_4OH \rightarrow NH_3 + H_2O$

Synthesis (Combination) Reactions

- A reaction that occurs when **<u>2 reactants</u>** combine to form **<u>1 product</u>**.

$H_2 + O_2 \rightarrow H_2O$

$Ag + S \rightarrow Ag_2S$

$Al + Cl_2 \rightarrow AlCl_3$

$NH_3 + HCl \rightarrow NH_4Cl$

Specific Synthesis Reaction

Opposite of Decomposition!

- **M**O + CO_2 → **M**CO_3

  Where M is any metal!

  $K_2O + CO_2$ →

- **M**O + H_2O → **M**OH

  $CaO + H_2O$ →

- **M**Cl + O_2 → **M**ClO_3

  $KCl + O_2$ →

Specific Synthesis Reaction

- NO + H2O → Acid

  Where N is any nonmetal!

Opposite of Decomposition!

$N_2O_3 + H_2O \rightarrow$ nitrous acid

$N_2O_5 + H_2O \rightarrow$ nitric acid

$P_2O_3 + H_2O \rightarrow$ phosphorus acid

$P_2O_5 + H_2O \rightarrow$ phosphoric acid

$SO_2 + H_2O \rightarrow$ sulfurous acid

$SO_3 + H_2O \rightarrow$ sulfuric acid

Combustion Reactions

- A reaction that occurs when a **<u>hydrocarbon</u>** reacts with **<u>O2 gas</u>** to form **<u>CO2 and H2O</u>**.

$$CH_4 + O_2 \rightarrow CO_2 + H_2O$$

$$C_4H_8 + O_2 \rightarrow CO_2 + H_2O$$

$$C_2H_6 + O_2 \rightarrow CO_2 + H_2O$$